MISSION SUPPORT
FISCAL YEAR 1998 ESTIMATES
BUDGET SUMMARY

OFFICE OF SAFETY AND MISSION ASSURANCE
SAFETY, RELIABILITY, MAINTAINABILITY
OFFICE OF THE CHIEF ENGINEER

SUMMARY OF RESOURCES REQUIREMENTS

SAFETY, RELIABILITY, MAINTAINABILITY, AND QUALITY ASSURANCE	FY 1996	FY 1997	FY 1998
Policy, oversight, and standards	13,175	14,900	13,600
Quality management	9,650	10,000	7,800
Software assurance	6,000	6,300	5,500
Engineering	10,200	7,600	10,900
Total	**39,025**	**38,800**	**37,800**

Distribution of Program Amount by Installation	FY 1996	FY 1997	FY 1998
Johnson Space Center	4,509	4,330	5,200
Kennedy Space Center	1,959	1,150	900
Marshall Space Flight Center	3,710	3,170	2,300
Stennis Space Center	495	350	200
Ames Research Center	5,129	6,970	6,900
Dryden Flight Research Center	197	430	400
Langley Research Center	3,955	2,150	5,200
Lewis Research Center	4,027	4,120	2,500
Goddard Space Flight Center	4,655	4,940	4,800
Jet Propulsion Laboratory	8,842	7,740	5,600
Headquarters	1,547	3,450	3,800
Total	**39,025**	**38,800**	**37,800**

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SAFETY, RELIABILITY, MAINTAINABILITY, AND QUALITY ASSURANCE

PROGRAM GOALS

NASA's Safety, Reliability, Maintainability, and Quality Assurance (SRM&QA) program invests in the safety and success of all NASA programs. The SRM&QA program develops insight into NASA's programs and performs independent oversight that contributes to program safety and success. The program develops and promulgates necessary NASA-wide safety and risk management policies, standards, and guidelines. Up-front quality management activities focus on reducing costs, improving safety and reliability, including the development and application of SRM&QA tools to support better, faster, cheaper program development. Software assurance activities include the implementation of NASA's software assurance improvement program; development of tools and techniques; and oversight of the performance of independent verification and validation (IV&V) for critical flight, ground control, and robotics system software. The SRM&QA program develops NASA-wide engineering policies, standards, and guidelines; promotes the use of industry and international standards for spaceflight systems; sponsors the development and demonstration of methodologies for improved design, test, and validation of systems and enhanced systems engineering capability; supports independent review of proposed and on-going programs; provides support to the NASA Program Management Council (PMC); and, investigates advanced aerospace concepts.

STRATEGY FOR ACHIEVING GOALS

The SRM&QA program supports the activities of the Office of Safety and Mission Assurance (OSMA) and the Office of the Chief Engineer (OCE). The OSMA advises the Administrator and provides leadership in promoting and ensuring the safety and quality of all NASA programs through oversight of NASA programs and development of Agency-wide Safety and Mission Assurance (S&MA) policies and standards. OSMA efforts in the Policy, Oversight and Standards; Quality Management; and Software Assurance programmatic areas assist NASA's Strategic Enterprises in accomplishing their goals in a safe and efficient manner. The OCE provides a focus for NASA's engineering discipline, oversees application, and improves

NASA's practices and capabilities through targeted initiatives in the Engineering programmatic area. The Advanced Concepts program for conceptual study of new and unconventional aerospace ideas is also part of the Engineering area beginning in FY 1998.

The Policy, Oversight, and Standards area addresses specific safety and mission assurance needs in the new environment of better, faster, cheaper missions and provides safety oversight and flight readiness assessments for NASA programs. Documentation and analysis of NASA experience in the SRM&QA disciplines, mishap investigations, monitoring compliance with the Occupational Safety and Health Act, and emergency preparedness planning improve safety and risk management in NASA programs. NASA's implementation of the International Organization for Standards' family of international quality standards (ISO 9000), the NASA Engineering and Quality Audit, and the Advanced Quality Practices program seek to improve the quality of NASA's contracted work.

The Quality Management area supports the early introduction of risk management and tailored safety, reliability and quality requirements into aerospace systems design and manufacture. The expected results are decreased lifecycle costs for NASA programs by reducing or eliminating costly redesign late in development and test, and increased probability of mission success. Specific efforts in qualification test methods; non-destructive evaluation (NDE) technologies; electrical, electronic, and electro-mechanical (EEE) parts and packaging; and flight performance support these goals. The Quality Management area also provides direct SRM&QA support to robotics, aeronautics, and expendable launch vehicle programs.

The Software Assurance program supports the development of software assurance standards, practices, and technology to evaluate flight system, mission control, and science data system software. The goal is assured, improved performance and reliability of the increasingly complex and critical facility, ground system, and flight system software used in NASA programs.

The Engineering area provides independent evaluation of engineering technical and policy issues and coordination of engineering capability development through NASA's Engineering Management Council. Development of NASA engineering standards and policies and the use of appropriate industry, national, and international standards will improve interoperability and reduce the costs of aerospace systems; while improved practices for systems engineering, structural analysis, and test methods will increase the reliability and effectiveness of NASA programs. The Langley Research Center (LaRC) will provide independent evaluation of proposed and on-going programs in support of the NASA PMC review process. The Advanced Concepts program provides an avenue for introducing new ideas for advanced aerospace architectural and systems concepts into NASA programs. The program's goal is to stimulate and evaluate concepts from both internal and external sources, and to ensure that ideas that show merit are considered for support by NASA program offices.

MEASURES OF PERFORMANCE

Title	Metric Description	FY 1996 Results
Independent Assessments, Oversight, and Reviews	Contribute to the safety and success of NASA missions by ensuring that programs have resolved all technical issues prior to flight. Evaluate adequacy of NASA SRM&QA and Engineering capabilities; independently assess critical NASA issues.	OSMA conducted oversight for 8 successful Shuttle flights and 6 successful spacecraft launches. OSMA conducted 9 Center functional self-assessment reviews, 7 independent spot checks and staff reviews at Centers, and an operational safety review at NASA Headquarters.
Mishap Prevention	Contribute to reducing the number of accidents at NASA facilities and lessening productivity losses.	NASA's FY 1995 lost time injury rate decreased 28% from FY 1994, to a 10-year low of 0.31 lost workdays per 200,000 hours worked. Safety-related property losses were $2.0 M, down from $2.9 M in FY 1994. FY 1995 is the last year for which complete data is available.
Systems Engineering	Improve and expand the use of integrated analytic methods to perform the systems engineering analyses required to define and optimize new missions and to ensure that development programs meet mission requirements.	A system requirements and interface verification methodology (PATHS) developed at the Johnson Space Center (JSC) has been applied to the Space Station and adopted by the Jet Propulsion Laboratory (JPL) as a design tool.
Quality Management	Support spacecraft projects and technology development by providing early risk management and quality studies for maximum benefit at project completion.	OSMA successfully implemented risk management approaches early in the lifecycle for the New Millennium program, Deep Space I mission and for microdevices technology development. OSMA completed an integrated, multi-Center mission assurance program for the Aeronautics High Speed Research program and initiated activities to develop a quality assurance program for the Advanced Subsonics Technology program.

Engineering Standards and Practices	Improve technical guidance for NASA programs by integrating demonstrated technologies and lessons learned into Agency-wide standards that increase commonality and interoperability of NASA aerospace systems.	NASA issued 6 standards for structural design and test that consolidate and improve on previously conflicting procedures. NASA Fracture Control Analysis tools were adopted by the Federal Aviation Administration (FAA) and the Air Force.
Safety and Quality Requirements and Standards	Replace NASA standards with US and international industry standards wherever possible. Develop NASA standards where required. Emphasize compliance and adoption of ISO 9000. Reduce cost of procuring flight and ground systems.	NASA adopted ISO 9000 as its quality standard; implementation in new contracts has begun. OSMA reduced NASA S&MA policy documents and handbooks from 55 to 30 (3,000 to 1,200 pages) and issued a Software Safety standard.
Advanced Concepts	Stimulate and evaluate advanced aerospace architectural and systems concepts to enable, enhance, and/or lower the costs of NASA missions.	Eight advanced concepts research projects were initiated with universities and private institutes.
Technology Evaluation	Evaluate reliability and improve utilization of advanced but maturing technologies through ground and flight demonstration.	Higher reliability laser initiated ordinance technology was demonstrated on two launch vehicles, including the commercial Pegasus vehicle.
Test Effectiveness	Provide environmental test data analyses correlated against flight performance to quantify specific guidance for tailoring test programs to specific mission requirements, thus enabling lower mission development costs for better, faster, cheaper spacecraft.	OSMA provided spacecraft projects with on-orbit flight performance results correlated against design, development, and mission processes to serve as guidance for future projects. OSMA also provided test program data correlated to specific science mission requirements for tailoring testing as part of the design and development validation process.

EEE Parts and Packaging	Qualify advanced parts and packaging technologies to reduce size and power requirements for spaceflight systems. Facilitate use of most reliable advanced components through development and use of parts selection databases.	Parts selection tools and radiation and qualification testing enabled selection of most reliable parts available for New Millennium missions.
Aerospace Batteries	Develop design guidance and qualify advanced battery chemistries; perform operational evaluation of flight battery systems.	OCE conducted life tests and flight-cycle simulations of battery cells for spacecraft and ISS. Management of the battery program is moved to the Office of Space Science in FY 1998.
Non-Destructive Evaluation (NDE)	Develop and certify improved NDE methods for aerospace manufacturing and operations. Reduce manufacturing and test costs by reducing teardowns, scrappage, and replacements caused by destructive testing.	An orbiter window defect analyzer was certified for production use, reducing costs and improving inspection confidence. An NDE approach for silicon nitride ball bearings for advanced turbopumps was developed.

ACCOMPLISHMENTS AND PLANS

In FY 1996, standards were completed for orbital debris (including assessment software) and oxygen and hydrogen safety. A joint test program with the Japanese Space Agency, NASDA, on liquid oxygen and hydrogen explosion safety distances was completed. Assessments and evaluations included Center S&MA self-assessments, several hazardous facility assessments, the Mars Pathfinder Safety Evaluation Report, and an independent assessment of initial program risk management processes for the X-33. Probabilistic risk assessments were performed for the Soyuz Crew Escape Vehicle and ISS. Shuttle probability estimates were revised. The ISS IA developed an independent critical risk assessment matrix and performed special technical and programmatic assessments. Center implementation plans for ISO 9000 were developed, kickoff orientation delivered, and compliance gap analysis completed. Training courses were developed and piloted for Certified Quality Engineer, Certified Reliability Engineer, and Certified Quality Technician. Nineteen computer-based courses were developed in S&MA disciplines including NDE, contractor oversight, and performance-based

contracting. A comprehensive on-line S&MA training catalog was also developed. Calibration standards for intrinsic voltage, and ultra-low and very high pressures were developed. Also, a pooled process for calibrating equipment at all Centers was instituted. A user-friendly lessons learned database was placed on the World-Wide Web, and alternative approaches to the current Failure Modes Effects Analysis/Critical Items List risk assessment were developed. Eight Shuttle flights were supported, and improved data collection techniques reduced S&MA costs for ground processing.

Product and mission assurance requirements were specifically tailored for Mars Pathfinder, Mars Rover, High Speed Research (HSR), and Advanced Subsonic Technology (AST); and S&MA was involved early in New Millennium program planning. NDE techniques for screening advanced turbopump silicon nitride ball bearings (ultrasonic), for composite pressure vessel certification and acceptance testing, and for composite debond detection (laser shearography) were developed. An automated orbiter window defect analyzer was developed and certified for field use.

Operations and maintenance funding for the Fairmont, WV, IV&V facility supported software assurance on Cassini, ISS, Shuttle, and Earth Observing System Data Information System. A pilot formal methods approach verified complete software assurance requirements for Cassini. Additionally, a quantitative software methods and measurements guidebook was baselined for Shuttle and the Space Operations Management Office. Moreover, software domain reuse principles were applied to wind tunnel control. Assurance techniques continue to be developed for complex software systems, and a software safety guidebook was produced.

In FY 1996, the OCE led the development of a qualification process to enhance the reliability of commercial launch services acquired by NASA and led the Pegasus XL Return to Flight Review Teamís efforts to support program mission success. The OCE provided leadership to develop the NASA Implementation Plan for the Federal Laboratory Review; approved for NASA-wide application a series of structural design and test standards; and established a Center-led program to implement additional consolidation and upgrades of current engineering practices. The Design, Test, and Verification program extended the NASA fracture analysis methodology to aging aircraft problems through cooperative agreements with the FAA. This program also supported verification tests of the damage-reducing, force limited vibration technique to additional payloads and began planning for a Shuttle flight verification of the technique. The OCE Battery program conducted life tests and operational simulations of NiCd and NiH2 battery cells in support of spacecraft and Space Station qualification programs. JPL used the Battery Test Bed to develop and verify power management and optimization techniques for on-orbit spacecraft. Eight competitively selected projects were initiated with Advanced Concepts Research Fellows at universities and private institutes. Topics included propulsion, inflatable structures, spacecraft architectures, electronic components, and robotics. Contracted studies to examine advanced concepts for highly reusable space transportation systems were initiated, and a "virtual research center" system was deployed.

In FY 1997, OSMA will conduct oversight for NASA's seven planned Space Shuttle flights. Transition to the Shuttle Flight Operations Contract (SFOC) will be supported, and an improved, low-cost, easy-to-use Problem Reporting and Corrective Action system will be completed. The ISS IA will continue to evaluate the program's technical health and capability to safely achieve its program objectives, including software IV&V, with co-funding from the Office of Space Flight. Significant lessons learned and reliability and test best practices will be collected and distributed throughout NASA. Risk management and assessment techniques will be developed, refined, and applied. Reliability-centered maintenance techniques and processes, an orbital debris hazard and risk mitigation process, and hydrogen fire detection and smoke movement modeling for high bays will be established. NASA, government, and private sector education and training courses will be identified and integrated into NASA's SRM&QA training and professional development curriculum. New courses will be initiated to cover gaps or advancing technology. Advanced quality concepts will allow routine use of private sector best practices, principles, and metrics to achieve comparable or improved safety, reliability, and quality at less cost. ISO 9000 will be fully integrated as NASA's baseline standard for quality management systems, and NASA Engineering and Quality Audits will be regularly employed.

Mission assurance support for New Millennium and other spacecraft and aeronautics programs such as High Speed Civil Transport and Advanced Subsonics will continue. Processes will be in place to develop appropriate S&MA requirements tailored to cost, schedule, and risk. Emphasis will be placed on test effectiveness and on correlating S&MA requirements with flight performance to provide real-time evaluation and feedback to the specific programs. Effective test programs incorporating test histories, flight performance, and flight results will be conducted. Advanced EEE parts and packaging techniques will be employed to develop qualification and test methods for fiber optics, micro-electro-mechanical systems, micro actuators, and sensors that determine quality and reliability issues. The space radiation effects program will determine microelectronic parts radiation tolerance.

Software assurance will continue to assure flight, ground control and robotics system software. Research initiatives in verification and validation techniques, tools, and training course development will be conducted. Verification and validation best practices will be identified and applied to mission critical software projects.

In FY 1997, in response to the decision to assign LaRC the responsibility for program analysis and evaluation, the OCE will expand the Langley Research Center (LaRC) mission concept and analysis capability. The LaRC, using it's broad systems analysis capabilities, will provide independent assessment of conceptual designs relative to design integrity, system/subsystem trades, life-cycle costs, schedule estimates, risk and risk mitigation approaches, and technology issues. The LaRC will lead the Agency's program evaluation (PMC reviews) by organizing and participating in inter-center Non-Advocate Review (NAR), Independent Annual Review

(IAR), and Independent Readiness Review (IRR) teams. In addition, it will provide specialized technical analysis to support review areas of particular concern. The OCE Standards program will continue consolidation of internal standards and will expand cooperative projects with non-Government standards, developing organizations to increase NASA use and support of national and international consensus standards. The Design, Test and Verification program will initiate projects applying probabilistic analysis techniques to structural design to improve design margin management and increase system assurance. The program will also complete assessment of the impact of chloro-flourocarbon replacement cleaners on lifetimes of precision mechanical systems such as scanners and gyroscopes. The OCE Applied Technology program will complete testing to evaluate solutions to failure modes of pyrotechnic operated valves. The Aerospace Battery program will complete technology evaluation and initiate cell tests for Li-ion battery systems; conduct performance testing and physical analysis for advanced NiCd, NiH2, and AgZn battery cells; and develop a stress test for NiH2 cell qualification procedure. The Advanced Concepts Program will be restructured to place more emphasis on soliciting external ideas and concepts. An External Advanced Concepts Institute will be established to provide a forum to stimulate and analyze external concepts for new systems approaches to NASA missions. Each Enterprise will establish a process for soliciting and evaluating relevant concepts from any source, and the "virtual laboratory" concept will be established at several Centers for faster, more effective concept evaluation.

The FY 1998 budget supports critical agency infrastructure to maintain safety and mission success with decreasing agency resources and dramatic changes in business practices. Specific safety and mission assurance needs in the new environment of better, faster, cheaper missions are addressed. Independent assessment of the Space Shuttle and ISS programs is maintained. OSMA will fully fund the ISS IA effort (including software), a change from prior years. Tools, techniques, and procedures are developed to replace audit-based oversight with insight. Process verification techniques and data will ensure process stability and capability. Assurance for better, faster, cheaper missions moves from rule-based to knowledge-based approaches. Acquisition reform goals of efficiency and effectiveness through the Single Process Initiative, ISO 9000, and Performance-Based Contracting (PBC) are supported. The Professional Development Initiative and related training course development responds to projected S&MA skill mix problems. The results of implementing ISO 9000, PBC, and other contracting initiatives will be evaluated. Seven Shuttle flights will be supported and the performance of the SFOC evaluated.

The test effectiveness program and techniques for trading risk will enable informed test planning for better, faster, cheaper missions and improved risk management. Development of advanced, unique NDE techniques and studies on probability of detection will support longer life aerospace components. Product assurance support for "Instruments on Chips" will help lead to dramatically lighter and lower power electronics. The EEE parts and packaging effort maintains the mission reliability of rapidly evolving semiconductor technologies by performing radiation screening for advanced new parts; establishing technology readiness for

insertion of emerging technology into microspacecraft; enabling the selection of commercial-off-the-shelf devices for better, faster, cheaper spacecraft and instruments; and, providing assurance for micro-electro-mechanical systems devices.

The Software Assurance program will continue to research, develop, pilot, and evaluate standards, tools, techniques, and processes to ensure the safe and reliable performance of increasingly complex critical mission software.

In FY 1998, the OCE's Standards program will establish a "Preferred Standards" system for NASA that completes consolidation of design practices and integrates the use of national and international consensus standards in space system development, test and implementation. Continued development of international standards for space systems through ISO will assist international cooperation and enhance U.S. competitiveness. International Product Data Standards will be used in system design and analysis for structures, thermal systems, and optical systems. Improvements to design, test, and validation capabilities will focus on improving analytic methods and tools for evaluation of structural design. The Aerospace Battery Technology program will be transferred to the Space Science Enterprise in FY 1998 to continue qualification of advanced chemistries and operational support and evaluation of flight battery systems. The LaRC will continue to independently assess advanced mission concepts and will assume full responsibility for supporting NASA Program Management Council reviews of proposed and ongoing programs. New and enhanced analytical methods and tools for Advanced Concepts will be incorporated at NASA Centers to enable simulation-based design, collaborative computing, and interactive design team studies. The External Advanced Concepts Institute will sponsor workshops and conferences to focus attention on promising new high-potential technology areas for future NASA missions.